

REMARKS

By the present amendment, claims 1 and 5 to 9 are pending in the application.

Claim Amendment

Amended independent claim 1 is a combination of the subject matter of prior independent claim 1 and prior, now canceled, dependent claims 2, 3 and 4.

§103

In the Office Action mailed August 12, 2008, claims 1 to 3, 8 and 9 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 52-070918 to Ishiguro in view of U.S. Patent No. 6,120,578 to Nakato.

In the Office Action mailed August 12, 2008, claims 4 to 7 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 52-070918 to Ishiguro in view of U.S. Patent No. 6,120,578 to Nakato and in further view of EP 0 906 960 to Nabeshima.

These rejections, as applied to the amended claims, are respectfully traversed.

The Present Invention

The present invention provides a steel containing few alumina clusters suitable for automotive and structural sheets, wear-resisting plates, oil-well tubes and is based on the following discoveries.

1). Low melting oxides FeO and $\text{FeO} \cdot \text{Al}_2\text{O}_3$ are present as binders between alumina particles in clusters.

2). Agglomeration and coalescence of alumina particles in liquid steel and at the surface of Ar gas bubbles are preventable by reducing such binders by appropriate quantities of REM.

3). If more than a necessary quantity of dissolved REM remain in liquid steel, large quantities of composite oxides comprising REM-oxide and alumina are formed by reaction between liquid steel and slags and impair the cleanliness of the liquid steel.

A characteristic features of the present invention is a steel containing alumina clusters consisting essentially of; in mass %, C: 0.0005 to 1.5%, Si: 0.005 to 1.2%, Mn: 0.05 to 3.0%, P: 0.001 to 0.1%, S: 0.0001 to 0.05%, Al: 0.005 to 1.5%, and T.): less than 80 ppm, with the remainder iron and unavoidable impurities, where the alumina clusters are oxide-based inclusions consisting essentially of alumina and REM-oxide containing REM-oxide of not less than 0.5 mass % and not more than 15 mass %, the mass ratio of total REM to total oxygen (T.O.), i.e., REM/T.O., is not less than 0.05 and not more than 0.5, and where total REM is less than 0.1 ppm and less than 10 ppm and dissolved REM is less than 1 ppm.

Patentability

Japan No. 52-070918 (“JP ‘918”)

JP ‘918 discloses a method for manufacturing a clean steel characterized by an attempt, by adding, to an aluminun-deoxygenated or aluminum/silicon-deoxygenated molten steel, 0.001 - 0.05% of one or more types of molten steel surface activators selected from among Se, Sb, La and Ce with respect to said molten steel and to minimize non-metallic inclusions consisting essentially of alumina clusters.

However, the specification of JP ‘918 clearly discloses that JP ‘918 provides a cleaned steel by adding a trace of a molten iron surface activating element(s) to a molten steel or by combining this additive(s) with an agitation mechanism for inducing the flotation, separation and removal, from the molten steel of non-metallic inclusions consisting essentially of alumina clusters and for minimizing non-metallic inclusions, such as alumina clusters. This means that alumina clusters are removed from a molten steel by floatation on the molten steel, and the steel does not contain alumina clusters in the molten steel.

Therefore, JP ‘918 is different from the present invention in which the steel contains alumina clusters. Further, JP ‘918 does not disclose or suggest the characteristic features of the present invention as discussed above.

U.S. Patent No. 6,120,578 (US ‘578”)

US ‘578 discloses to charge an alloy consisting of Al and two or more elements selected from Ca, Mg and REM into the molten steel to conduct deoxidation, and to adjust Al_2O_3 in the resulting inclusions to a range of 30 - 85%. This is a main feature of US ‘578. US ‘578 further discloses that the reason why the deoxidizing agent is the alloy of Al and two or more of Ca, Mg and REM is due to the fact that when the alloy is Al and one of Ca, Mg and REM, the formation of composite inclusion and the shape control thereof become unstable, and the effect of preventing the formation of aluminum clusters is insufficient. Hence the effect of satisfactorily improving the surface quality in a thin steel sheet cannot be achieved. Therefore, in US ‘578, the deoxidizing agent which is the alloy of Al and two or more of Ca, Mg and REM is an indispensable feature, and excludes only one deoxidizing agent, such as REM only.

In contrast, the present invention does not require two or more of Ca, Mg and REM as the deoxidizing agent. The present invention only use Al with REM oxide as the constitution of inclusions as defined in the claims. There are no examples in the present specification an oxide composed of Ca or Mg. The present invention further defines to control the REM-oxide-content in the oxide-based inclusions consisting essentially of alumina and REM-oxides to 0.5 - 15 mass % because when the REM-oxide-content is controlled within this range, agglomeration and coalescence of alumina particles can be inhibited and formation of coarse alumina clusters is prevented.

US ‘578 further discloses that a preliminary deoxidation is carried out to control the free oxygen contained in the molten steel to a concentration amount of not more than 200 wt ppm before adding the alloying elements in order to reduce the alloying elements content from the economical view point.

On the other hand, the present invention defines that the mass ratio of total REM to total oxygen (T.O.), i.e., REM/T.O., is not less than 0.05 and not more than 0.5 for preventing the formation of alumina clusters by means of the addition of alloying elements selected from REMs to a molten steel deoxidized by Al, and the amount of REM oxide contained in the oxide inclusions. This is not to reduce the amount of alloying elements as in US ‘578. Therefore, this feature of the present invention is not disclosed or suggested by US ‘578.

The Office Action takes the position that the total REM concentration and dissolved REM concentration defined in the present invention are substantially equal to the REM concentration of 0.4 ppm and the total oxygen amount of 18 ppm in Example 3 of US ‘578. However, the calculated value of the total oxygen content in US ‘578 is 40 ppm (Example 1), 42 ppm (Example 2) and 40 ppm (Example 3). These values are quite different from the present invention.

Therefore, US ‘578 is very different from the present invention.

EP 0 906 960 (“EP ‘960”)

The Office Action further takes the position that the subject matter of dependent claims 4 - 7 is not disclosed in US ‘578. The Office Action maintains that a person skilled in the art can easily conceive the subject matter of dependent claims 4 - 7 by combining US ‘578 and EP ‘960 because EP ‘960 discloses certain molten steel compositions. It is submitted that this understanding is incorrect. Note that the subject matter of prior dependent claim 4 is now part of amended independent claim 1.

Molten steel compositions disclosed in EP ‘960 are deoxidized by Ti, as shown in Table 1, as an indispensable feature, which is a quite different deoxidation by means of Al according to the present invention. Regarding inclusion formation, the compositional ranges targeted by EP ‘960 contain Ti oxide as shown in Fig. 2 of EP ‘960.

According to EP '960, the ranges of alumina: 82.4 - 98.5 wt % and REM oxide concentration: 0.5 - 15 wt, of the present invention, would cause nozzle clogging as shown in attached Fig. A which is based on Fig. 2 of EP '960. Therefore, the composition of the formed inclusions disclosed in EP '960 is quite different from that of the present invention.

It is therefore submitted that amended independent claim 1, and all claims dependent thereon, are patentable over JP '918 in view of US '578 and further in view of EP '960.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that application, as amended, be allowed and passed for issue.

Respectfully submitted,

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